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"20 kWe" NEP SYSTEM STUDIES

**Nuclear Propulsion Technical Interchange Meeting
LeRC Plum Brook Station
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Advanced Space Analysis Office**

**NASA Lewis Research Center
Advanced Space Analysis Office**

Introduction

- Investigate low power options for nuclear electric propulsion (NEP) demonstration missions
- Use technologies which are applicable to later NASA missions through growth and scalability
- What is desirable in a "demonstration" system/mission?
 - Applicable to "production" systems and missions
 - Technologies
 - Power levels
 - Temperatures
 - Applicable to NASA mission needs
- LeRC Inhouse power systems analysis:
 - Advanced Space Analysis Office
 - Power Technology Division

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Initial Study Groundrules

- **Mission**
 - 1998 - 2000 Launch
 - Launch to escape - No earth orbital spirals
 - Meaningful scientific return
 - Smallest feasible launch vehicle
- **System**
 - Near term technology
 - 2 - 3 year system lifetime
 - Scaled SP-100 reactor
 - Technology evolvable to 100 kWe needed for outer planet exploration missions
- Groundrules will evolve as study progresses

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Power System Groundrules/Assumptions

- 10 - 50 kWe
- 3 year life
- 2000 V to load
- 15 m reactor-to-payload separation distance
- 1.0×10^{12} n/cm²
- 5×10^4 rad gamma
- 17 degree half-angle
- 10 % excess heat rejection capacity

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Power System Technologies Assessed

Reactor

- "Customized" SP-100
 - Scaled to meet thermal power requirements
 - Reactor redesign required
- Prototypical 2.4 MWt SP-100
 - Current design
 - Thermal power "rich" for 10-50 kWe

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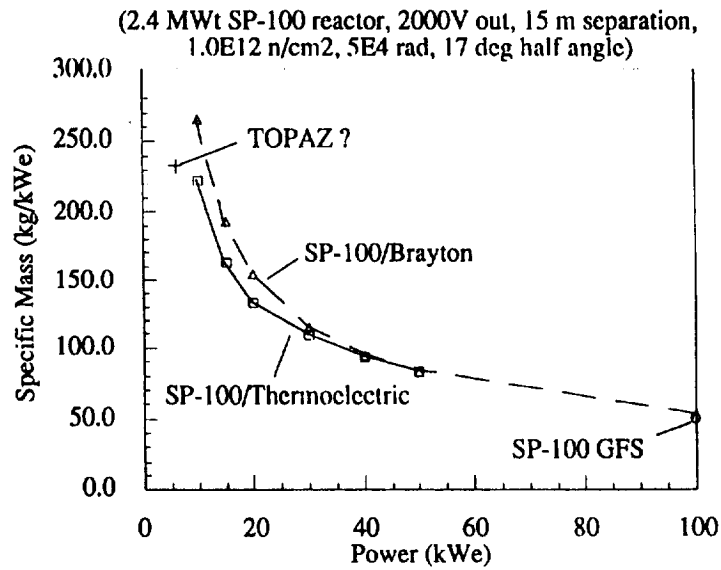
Power System Technologies Assessed (cont.)

Power Conversion

- Thermoelectrics
 - Current SP-100 program choice
 - Static
 - Power limited to approx. few 100's kWe
 - $z = 0.67 \times 10^{-3}$ 1/K multicouple (Aug. 92 projected)
- Brayton
 - Dynamic
 - Scalable to multimegawatts
 - 1144 K demonstrated technology
 - 0.9 recuperator effectiveness
 - 1 + 1 redundancy (100%)
- Stirling
 - Dynamic
 - Power limited to approx. 1 MWe
 - 1050 K demonstrated technology
 - 1 + 1 redundancy (100%)

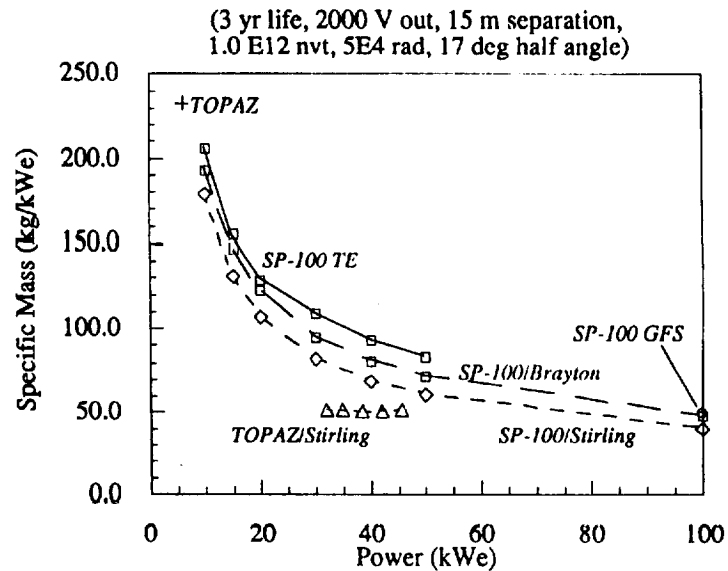
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"Prototype" SP-100 System Specific Mass



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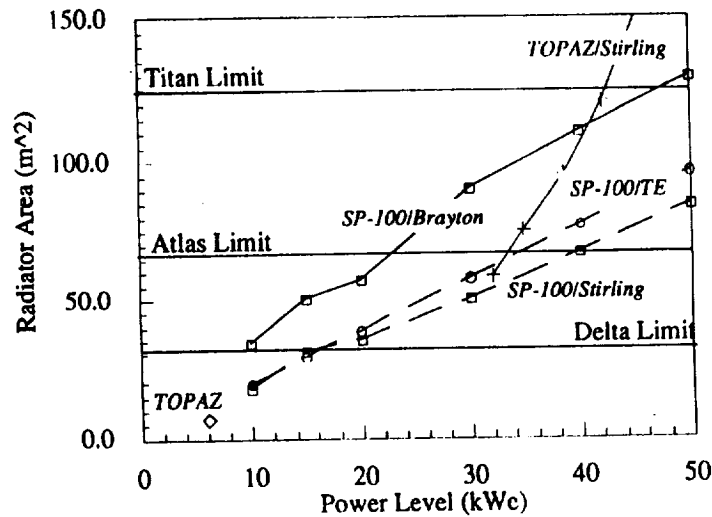
"Custom" SP-100 System Specific Mass



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NRP: System Concepts

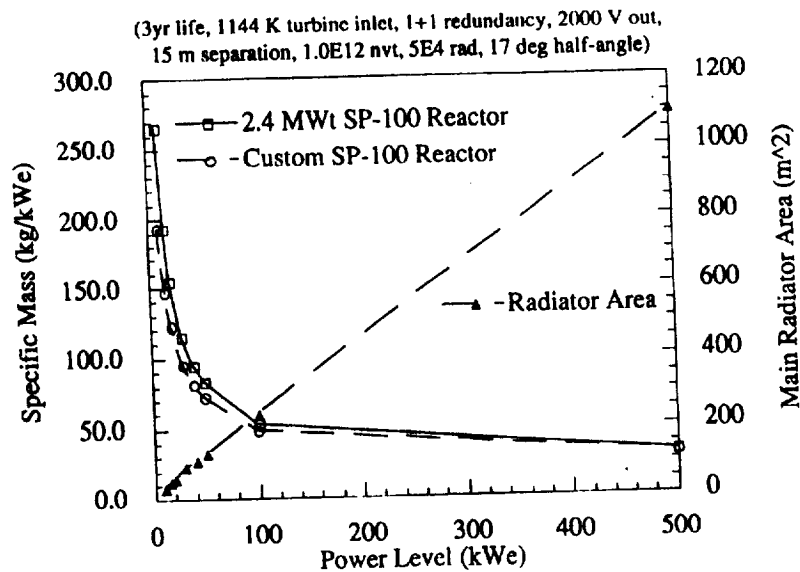
Radiator Packaging Limits

(No Deployment)



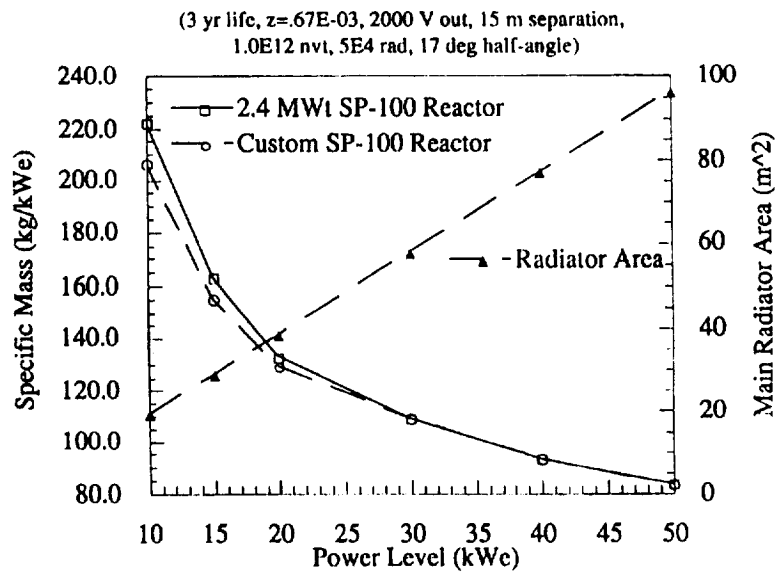
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Brayton System Specific Mass and Radiator Area



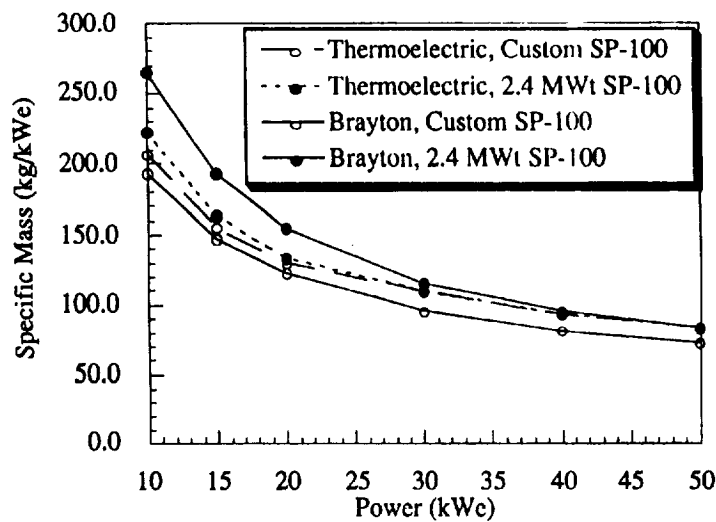
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Thermoelectric Specific Mass and Radiator Area



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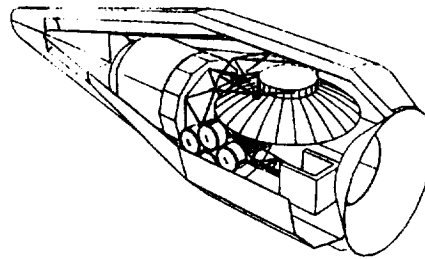
Specific Mass for "Prototype" vs. "Custom" SP-100-based Systems



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NEP: System Concepts

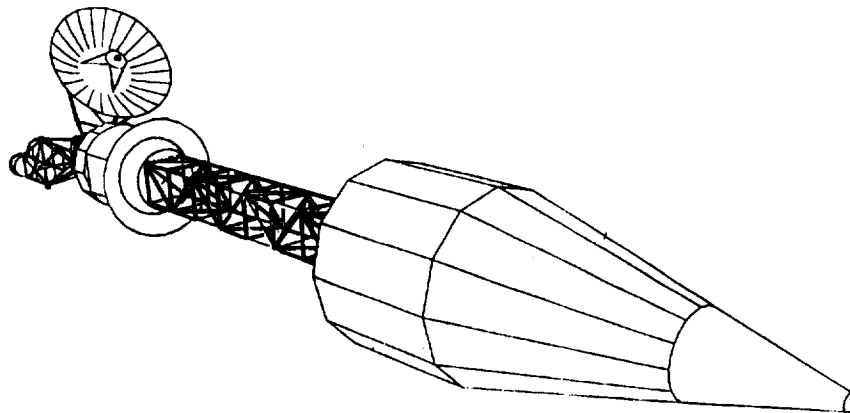
System Packaging Limits on Power Level (kWe)

ELV	TE	Stirling	Brayton
Delta	15	15	10
Atlas	35	40	20
Titan	>50	>50	50



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Conceptual NEP Science Mission Spacecraft Design

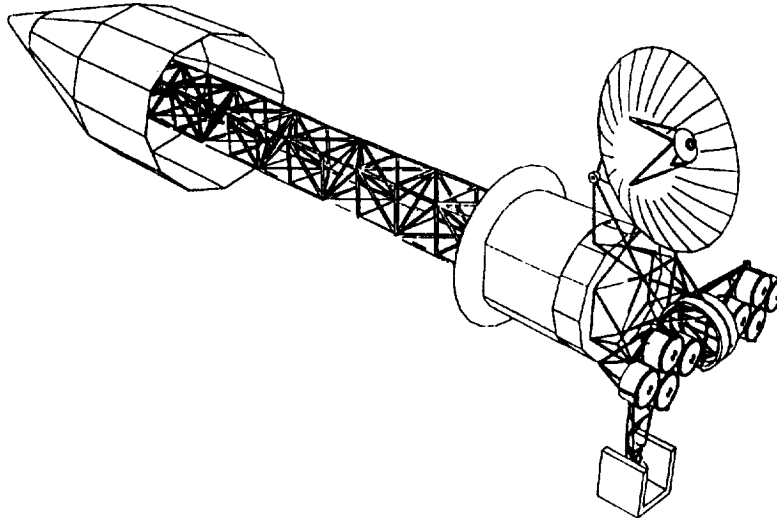


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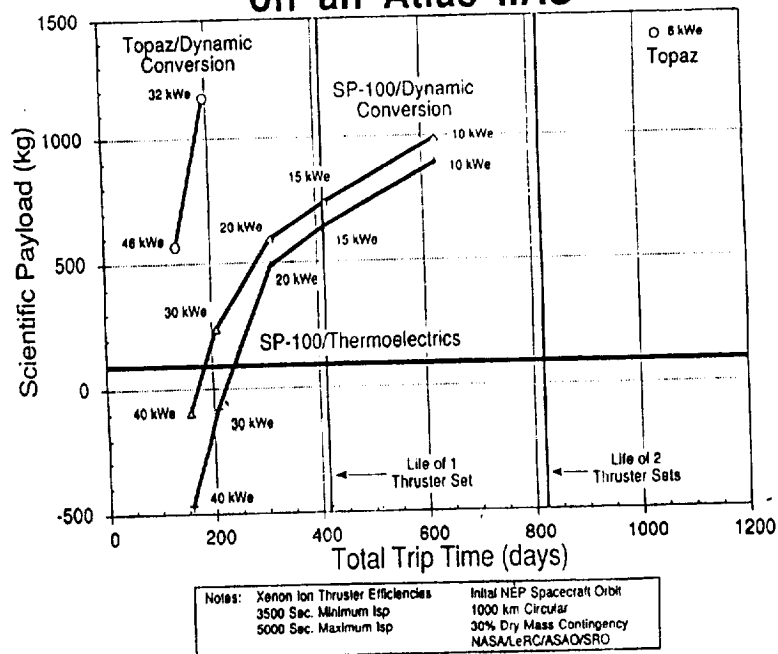
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Conceptual NEP Science Mission Spacecraft Design



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Van Allen Payload Delivery off an Atlas IIAS



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NEP: System Concepts

Summary

- Power system options for low power NEP demonstration missions investigated
 - 10-50 kWe
 - 2.4 MWt versus "Custom" SP-100
 - Brayton, Stirling, Thermoelectric
- Van Allen Mapper Mission identified as candidate 15 - 20 kWe demo.
- Investigation of other candidate missions continues

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